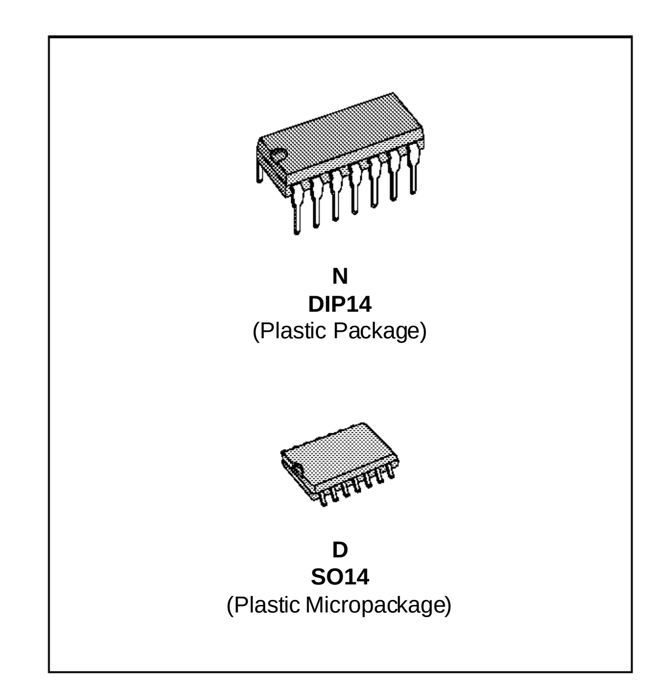


MC3303
MC3403 - MC3503

LOW POWER QUAD BIPOLAR OPERATIONAL AMPLIFIERS

- SHORT-CIRCUIT PROTECTED OUTPUTS
- CLASS AB OUTPUT STAGE FOR MINIMAL CROSSOVER DISTORTION
- SINGLE SUPPLY OPERATION : + 3 V TO + 36V
- DUAL SUPPLIES : ±1.5V TO ±18V
- LOW INPUT BIAS CURRENT : 500nA MAX
- INTERNALLY COMPENSATED
- SIMILAR PERFORMANCE TO POPULAR UA741



DESCRIPTION

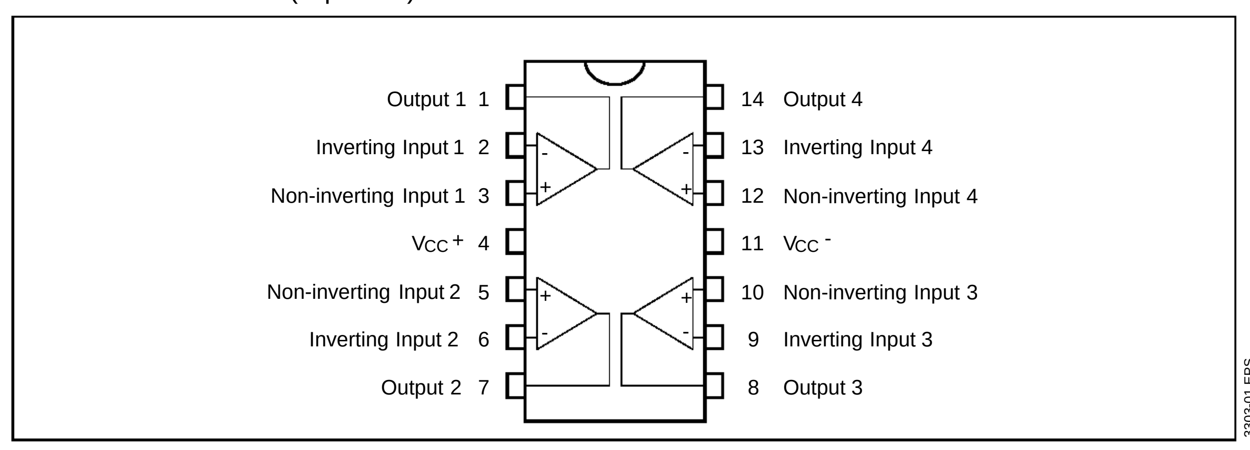
The MC3403 is a low-cost, quad operational amplifier with true differential inputs. The device has electrical characteristics similar to the popular UA741. However the MC3403, has several distinct advantages over standard operational amplifier types in single supply applications. The quad amplifier can operate at supply voltages as low as 3.0 volts or as high as 36 volts with quiescent currents about one third of those associated with the UA741 (on a per amplifier basis). The common-mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications.

ORDER CODES

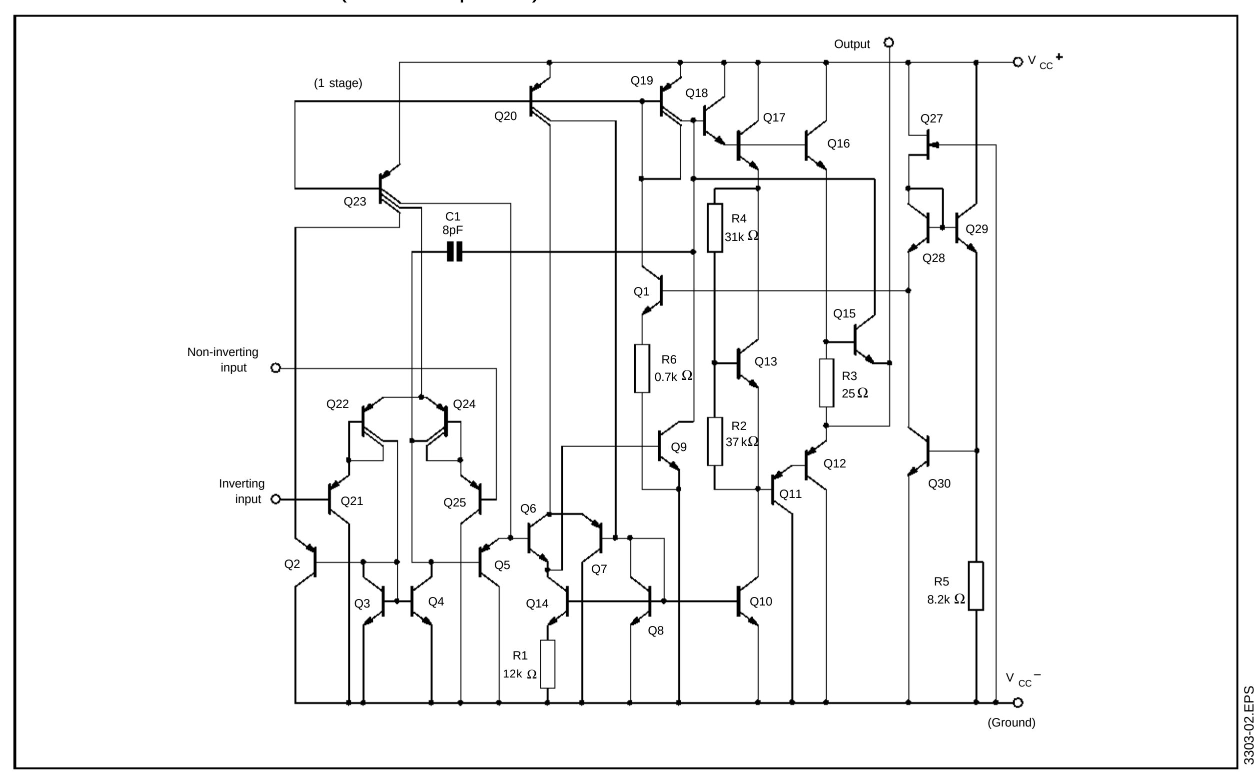
Part Number	Temperature Range	Package	
		N	D
MC3303	–40°C, +105°C	•	•
MC3403	0°C, +70°C	•	•
MC3503	–55°C, +125°C	•	•
Example : MC3403N			

3303-01.TBL

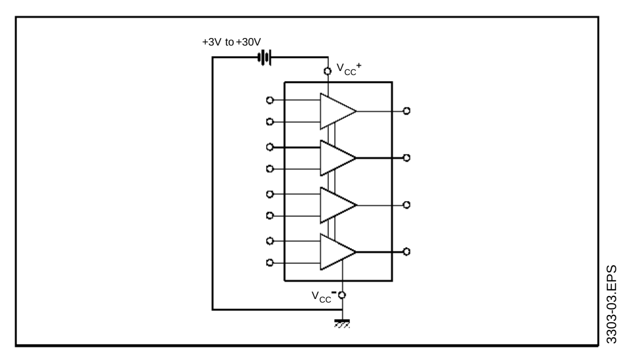
PIN CONNECTIONS (top view)



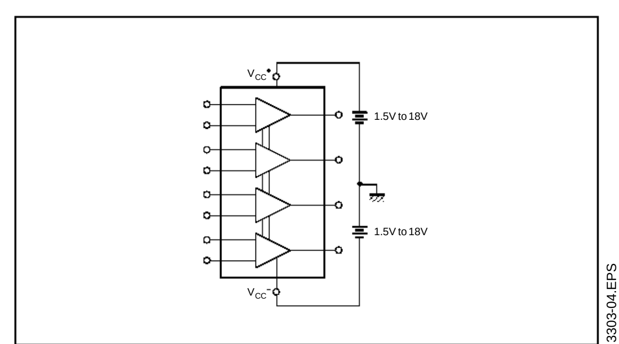
SCHEMATIC DIAGRAM (each amplifier)



SINGLE SUPPLY



DUAL SUPPLIES



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	MC3503	MC3403	MC3303	Unit
V_{CC}	Supply Voltage	±18 or 36	±18 or 36	±18 or 36	V
V_{id}	Differential Input Voltage	±36	±36	±36	V
V_i	Input Voltage (note 1)	±18	±18	±18	V
–	Output Short-circuit Duration (note 2)	Infinite			–
P_{tot}	Power Dissipation	500	500	500	mW
T_{oper}	Operating Free-air Temperature Range	–55 to +125	0 to +70	–40 to +105	^oC
T_{stg}	Storage Temperature Range	–65 to +150	–65 to +150	–65 to +150	^oC

3303-02.TBL

Notes :
1. For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.
2. Any of the amplifier outputs can be shorted to ground indefinitely ; however more than one should not be simultaneously shorted as the maximum junction temperature will be exceeded.

ELECTRICAL CHARACTERISTICS

V_{CC} = ±15V, T_{amb} = +25°C, (unless otherwise specified)

Symbol	Parameter	MC3303 - MC3403 MC3503			Unit
		Min.	Typ.	Max.	
V_{IO}	Input Offset Voltage ($R_S \leq 10k\Omega$) T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		1	5 6	mV
I_{IO}	Input Offset Current T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		2	50 200	nA
I_{ib}	Input Bias Current T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$		40	500 800	nA
A_{vd}	Large Signal Voltage Gain (V_O = ±10V, R_L = 2kΩ) T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$	50 25	200		V/mV
SVR	Supply Voltage Rejection Ratio ($R_S \leq 10k\Omega$) T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$	77 77	90		dB
I_{CC}	Supply Current, all Amp, no Load T_{amb} = 25°C MC3503 $T_{min.} \leq T_{amb} \leq T_{max.}$ MC3503		2.8	7 4 8 5	mA
V_{icm}	Input Common Mode Voltage Range T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$	– 15 – 15		+ 13 + 13	V
CMR	Common Mode Rejection Ratio ($R_S \leq 10k\Omega$) T_{amb} = 25°C $T_{min.} \leq T_{amb} \leq T_{max.}$	70 70	90		dB
I_{OS}	Output Short-circuit Current	10	30	45	mA
± V_{opp}	Output Voltage Swing T_{amb} = 25°C, R_L = 10kΩ R_L = 2kΩ $T_{min.} \leq T_{amb} \leq T_{max.}$, R_L = 2kΩ R_L = 10kΩ	12 10 10 12	13.5 13		V
SR	Slew Rate (V_I = ±10V R_L = 2kΩ, C_L = 100pF, T_{amb} = 25°C, unity gain)	0.35	0.5		V/μs
t_r, t_f	Rise Time and Fall Time (V_O = ± 20mV, R_L = 2kΩ, C_L = 100pF T_{amb} = 25°C, unity gain)		0.18		μs
K_{OV}	Overshoot (V_I = ± 20mV, R_L = 2kΩ, C_L = 100pF, T_{amb} = 25°C, unity gain)		10		%
Z_I	Input Impedance	0.3	1		MΩ
Z_O	Output Impedance		75		Ω
B_{om}	Power Bandwidth (R_L = 2kΩ, C_L = 100pF, A_v = 1, T_{amb} = 25°C, V_O = 2V_{pp}, THD ≤ 5%)		9		kHz
B	Unity Gain Bandwidth (V_O = 10mV, R_L = 2kΩ, C_L = 100pF, T_{amb} = 25°C, unity gain)		1		MHz
GBP	Gain Bandwidth Product (V_O = 10mV, R_L = 2kΩ, C_L = 100pF, f = 100kHz, T_{amb} = 25°C)	0.7	1		MHz
THD	Total Harmonic Distortion (f = 1kHz, A_v = 20dB, R_L = 2kΩ, V_O = 2V_{pp}, C_L = 100pF, T_{amb} = 25°C)		0.02		%
e_n	Equivalent Input Noise Voltage (f = 1kHz, R_s = 100Ω)		43		$\frac{nV}{\sqrt{Hz}}$

3303-03.TBL

ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	MC3303 - MC3403 - MC3503			Unit
		Min.	Typ.	Max.	
Øm	Phase Margin		60		Degrees
DV_{IO}	Input Offset Voltage Drift $T_{min.} \leq T_{amb} \leq T_{max.}$		10		µV/°C
DI_{IO}	Input Offset Current Drift $T_{min.} \leq T_{amb} \leq 25^oC$		50		pA/°C
V_{O1}/V_{02}	Channel Separation		120		dB

3303-04.TBL

ELECTRICAL CHARACTERISTICS

$V_{CC}^+ = 5V$, V_{CC-} = Ground, $T_{amb} = 25^oC$ (unless otherwise specified)

Symbol	Parameter	MC3303 - MC3403 - MC3503			Unit
		Min.	Typ.	Max.	
V_{IO}	Input Offset Voltage ($R_S \leq 10k\Omega$) T_{amb} = 25 °C $T_{min} \leq T_{amb} \leq T_{max}$		1	5 6	mV
I_{IO}	Input Offset Current $T_{amb} = 25^oC$ $T_{min.} \leq T_{amb} \leq T_{max.}$		2	50 200	nA
I_{ib}	Input Bias Current $T_{amb} = 25^oC$ $T_{min.} \leq T_{amb} \leq T_{max.}$		40	500 800	nA
A_{vd}	Large Signal Voltage Gain (V_O = 1.4 to 2.4V, $R_L = 2k\Omega$) $T_{amb} = 25^oC$ $T_{min.} \leq T_{amb} \leq T_{max.}$	10 5	200		V/mV
SVR	Supply Voltage Rejection Ratio ($R_S \leq 10k\Omega$) $T_{amb} = 25^oC$ $T_{min.} \leq T_{amb} \leq T_{max.}$	77 77	90		dB
I_{CC}	Supply Current (All Amp) MC3503		2.5	7 4	mA
V_{opp}	Output Voltage Range ($R_L = 10k\Omega$) $V_{CC} = +5V$ $+5 < V_{CC} \leq +30V$	3.3 V_{CC}^+-2V	3.5 V_{CC}^+-1.7V		V

3303-05.TBL

CIRCUIT DESCRIPTION

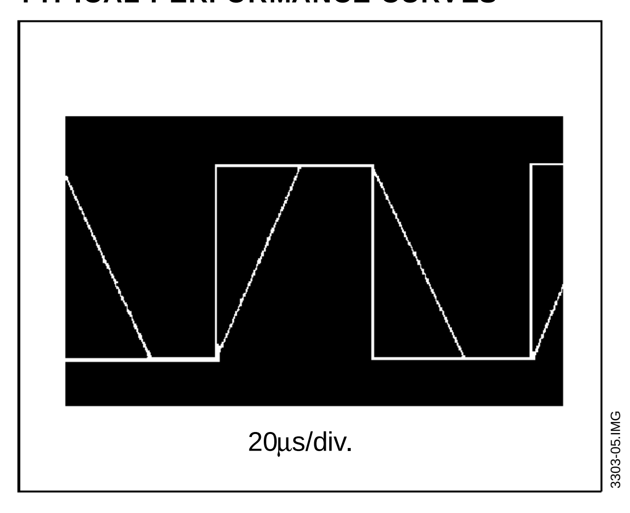
The MC3403 is made using four internally compensated, two-stage operational amplifiers. The first stage of each consists of differential input devices Q24 and Q22 with input buffer transistors Q25 and Q21 and the differential to single ended converter Q3 and Q4. The first stage performs not only the first stage gain function but also performs the level shifting and transconductance reduction functions. By reducing the transconductance a smaller compensation capacitor (only 8pF) can be employed, thus saving chip area.

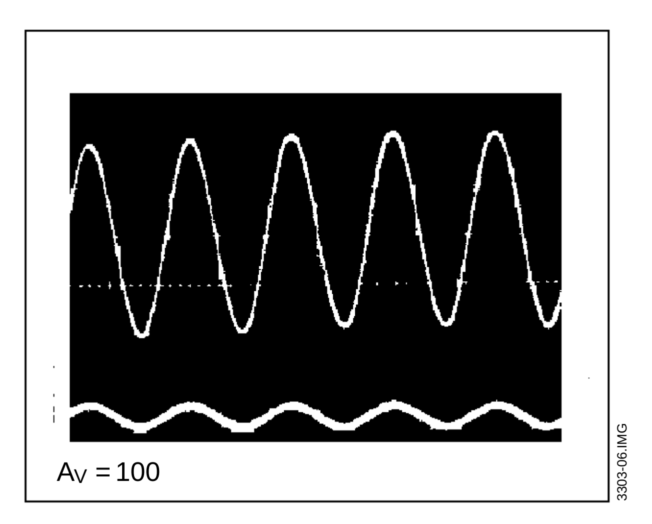
The transconductance reduction is accomplished by splitting the collectors of Q24 and Q22. Another feature of this input stage is that the input common-mode range can include the negative supply of ground, in single supply operation, without saturation either the input devices or the differential to single-ended converter.

The second stage consists of a standard current source load amplifier stage. The output stage is unique because it allows the output to swing to ground in single supply operation and yet does not exhibit any crossover distortion in split supply operations. This is possible because class AB operation is utilized.

Each amplifier is biased from an internal voltage regulator which has a low temperature coefficient thus giving each amplifier good temperature characteristics as well as excellent power supply rejection.

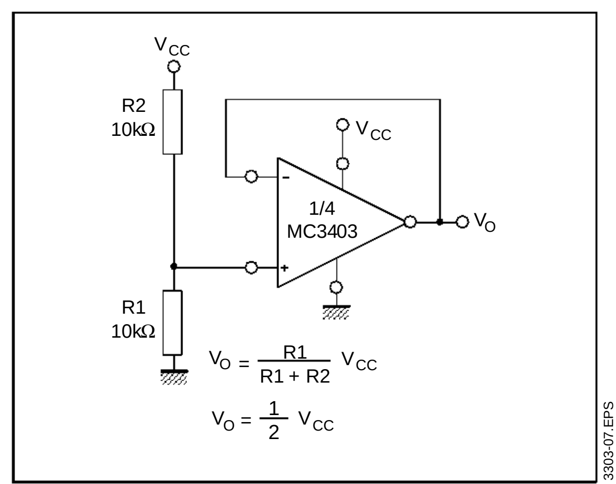
TYPICAL PERFORMANCE CURVES



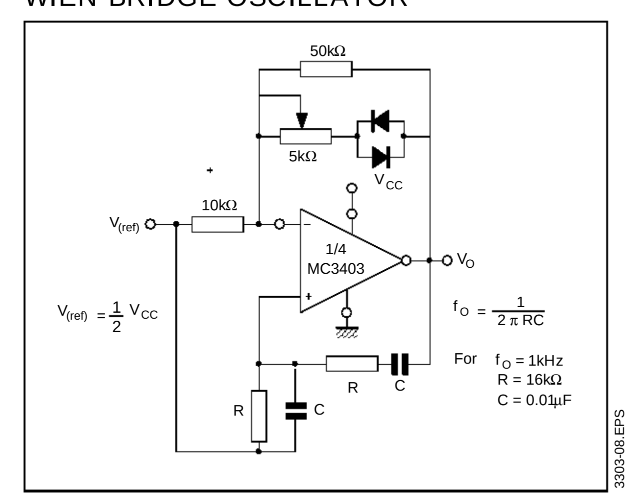


APPLICATION INFORMATION

VOLTAGE REFERENCE



WIEN BRIDGE OSCILLATOR



APPLICATION INFORMATION (continued)

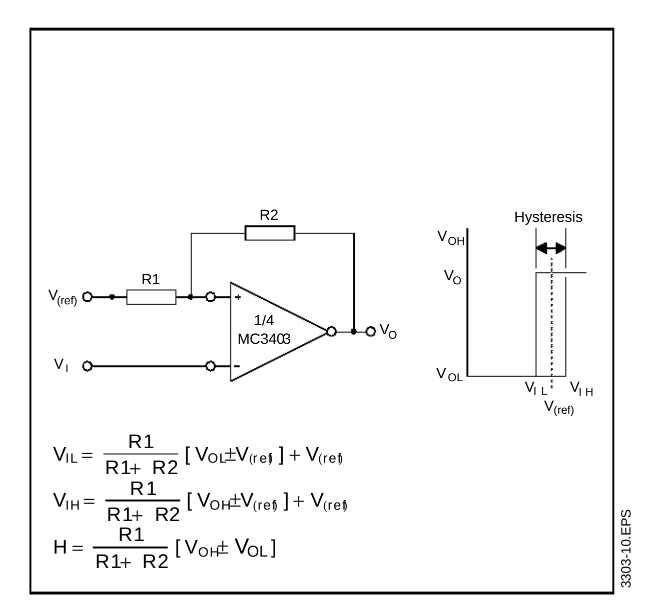
HIGH IMPEDANCE DIFFERENTIAL AMPLIFIER

e_1, e_2, 1/4 MC3403, $\frac{1}{C}R$, R, a R1, b R1, R1, e_o

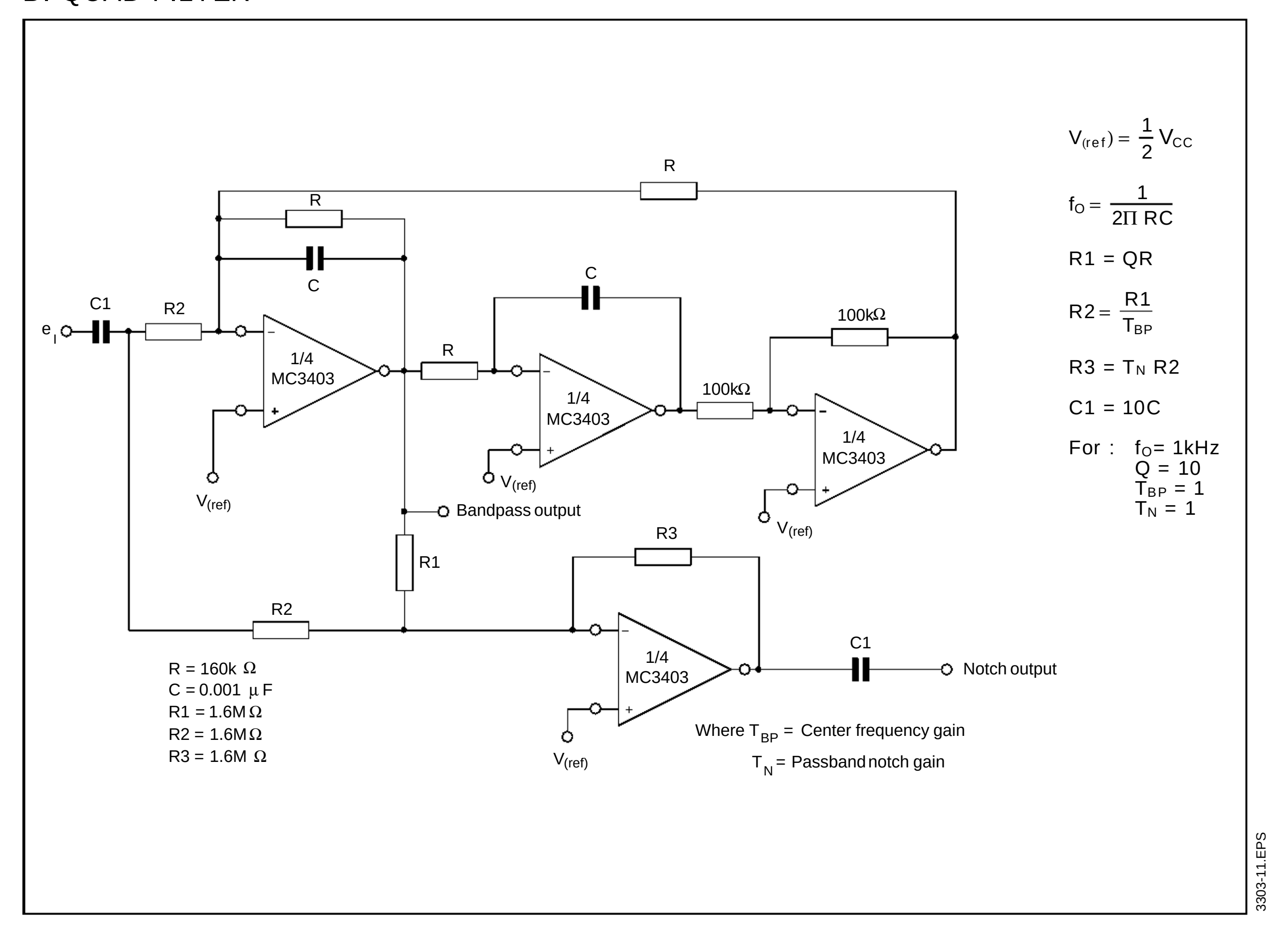
$e_o = C\,(1 + a + b)\,(e_2 - e_1)$

3303-09.EPS

COMPARATOR WITH HYSTERESIS

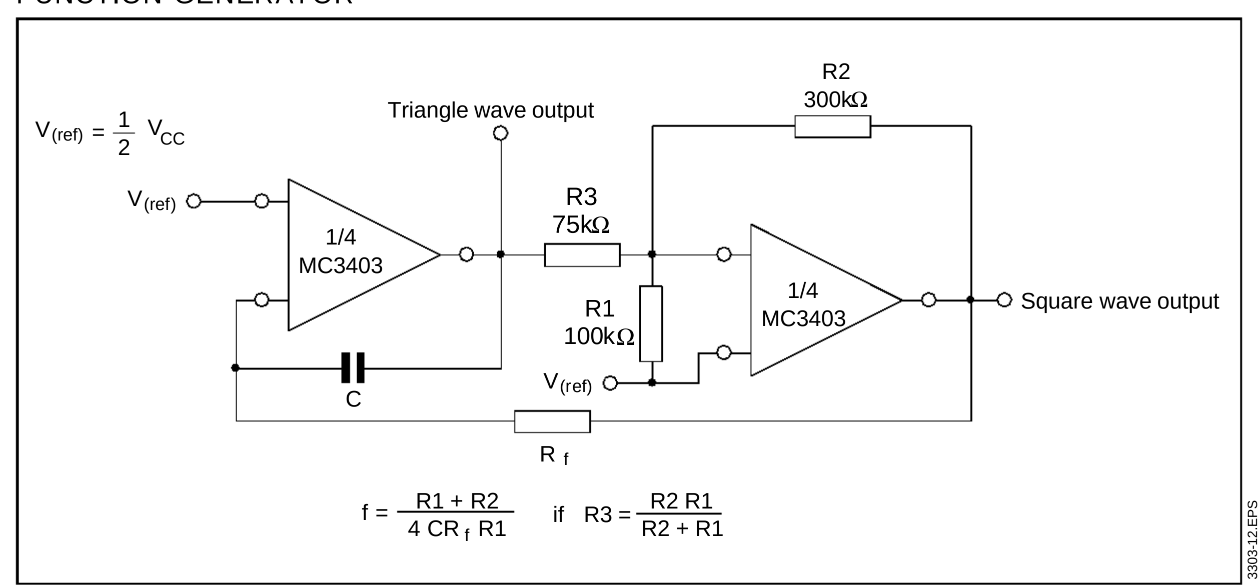


BI-QUAD FILTER

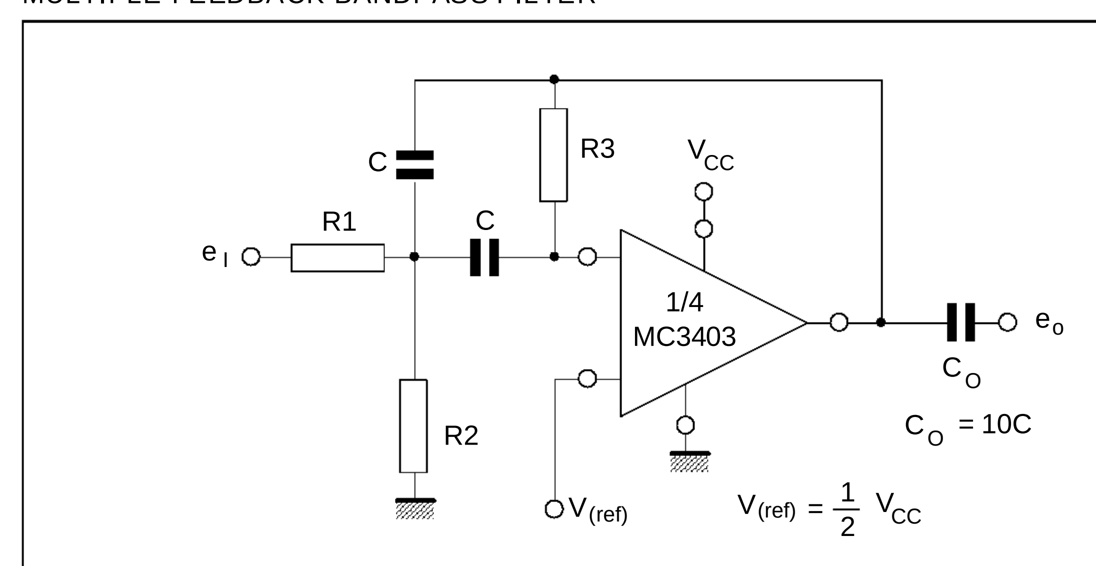


APPLICATION INFORMATION (continued)

FUNCTION GENERATOR



MULTIPLE FEEDBACK BANDPASS FILTER



Given f_o = Center frequency ; choose values f_o, C then $R3 = \frac{Q}{\pi f_o C}$

$A(f_o)$ = Gain at center frequency $R1 = \frac{R3}{2A(f_o)}$

$R2 = \frac{R1\,R5}{4Q^2\,R1 \pm R5}$

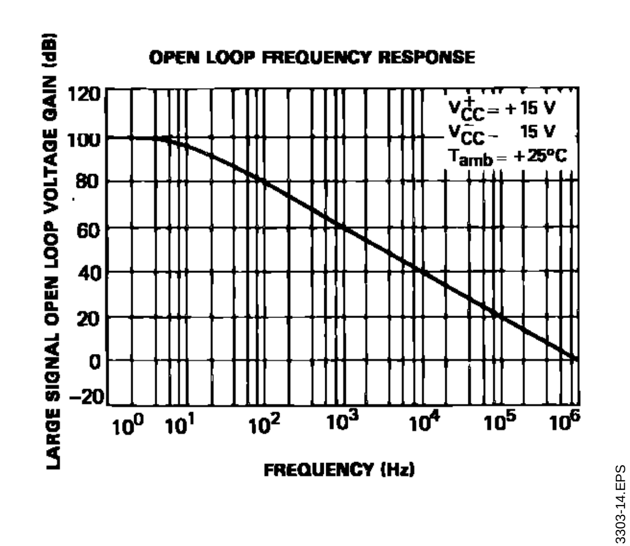
For less than 10% error from operational amplifier

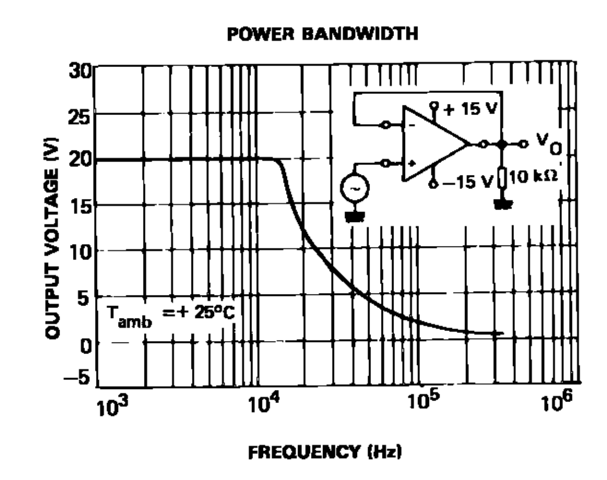
$\frac{Q_o f_o}{BW} < 0.1$ where f_o and BW are expressed in Hz

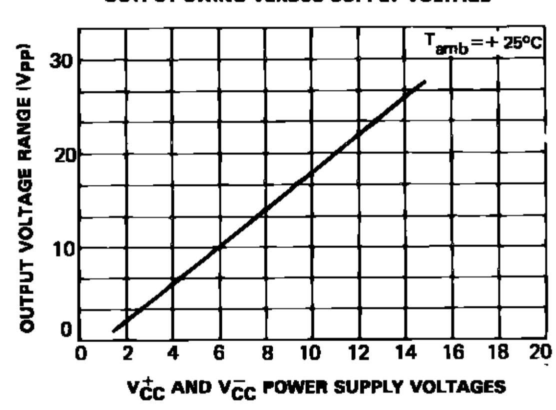
If source impedance varies, filter may be preceded with voltage follower buffer to stabilize filter parameters

3303-13.EPS

TYPICAL PERFORMANCE CURVES

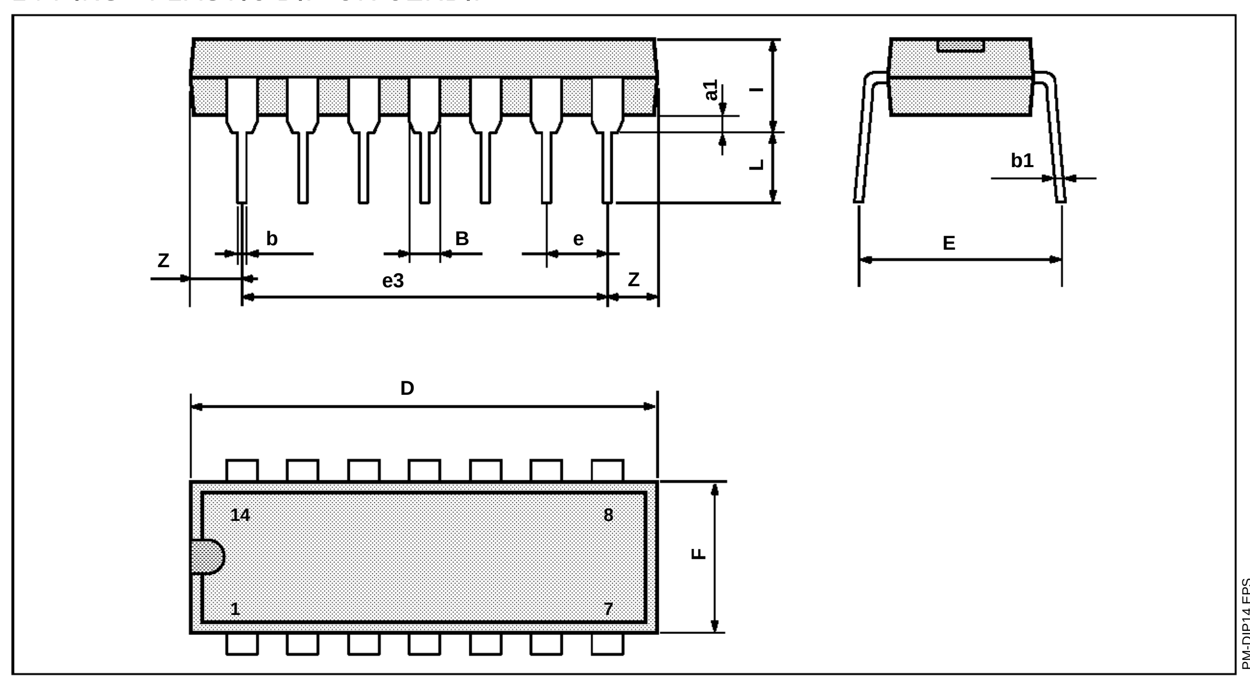






PACKAGE MECHANICAL DATA

14 PINS - PLASTIC DIP OR CERDIP

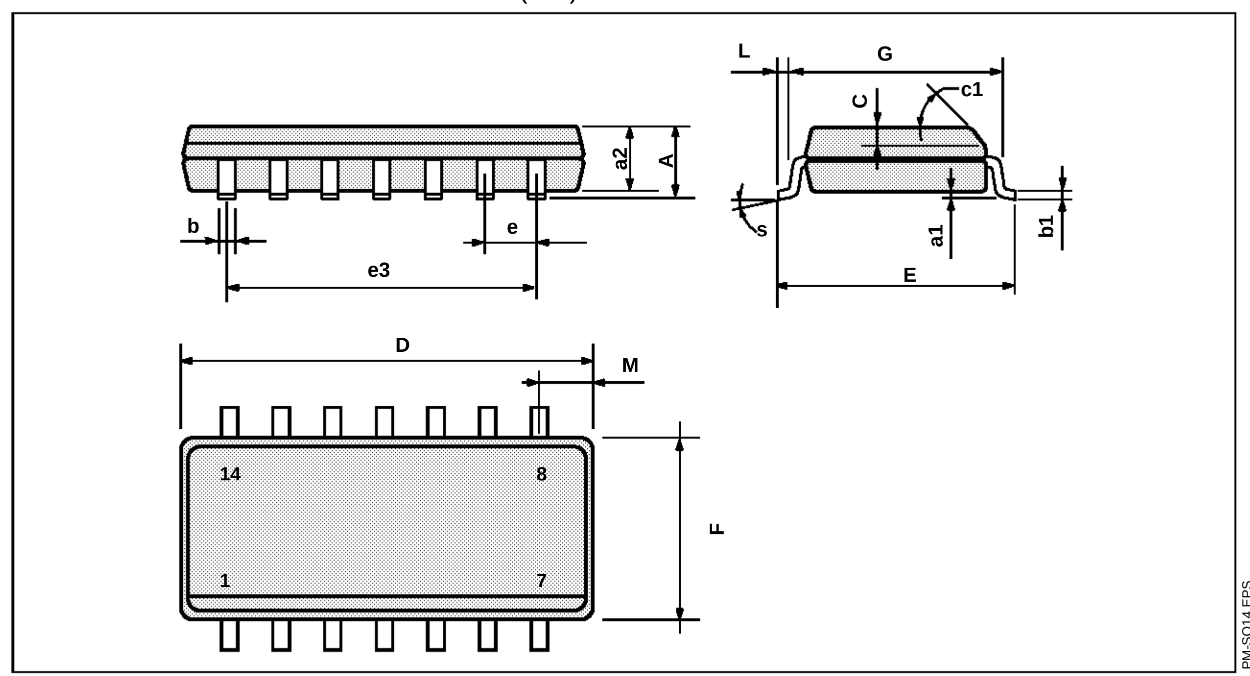


Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.51			0.020		
B	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		15.24			0.600	
F			7.1			0.280
i			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100

DIP14.TBL

PACKAGE MECHANICAL DATA

14 PINS - PLASTIC MICROPACKAGE (SO)



Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.2	0.004		0.008
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45° (typ.)					
D	8.55		8.75	0.336		0.334
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.150		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.020		0.050
M			0.68			0.027
S	8° (max.)					

SO14.TBL

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